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Related Art	(56)	Nil

The following statement is a full description of this invention, including the best method of performing it known to us :

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The invention relates to a plastics injection machine with a fixed-location, continuously rotatable worm feed and an intermittently operable closing device between the worm feed arrangement and the injection mould interrupting the supply of plastic to the injection mould.

A machine of this kind makes the injection of plastic articles possible. The worm feed is located in a feed casing which can be heated from the outside. In the vicinity of the rear end of the worm feed in the direction of delivery an opening is provided in the feed casing through which the plastic can be supplied in a fractionated form, mostly as a granulate. Through the rotation of the worm feed and the simultaneous heating of the feed casing, the plastic is converted during the feeding process into a masticated state, in which it is pressed through a connecting duct made in the form of a nozzle into the injection mould.

In contrast to the movably-located worm feeds, to which it is necessary to supply from time to time a quantity of raw plastic accurately metered according to the charge quantity of the injection mould, with a fixed-location worm feed it is possible to carry out a continuous feeding process, with the worm feed maintained in constant rotation. Here it is however necessary to provide the closing device between the front end of the feed casing and the injection mould, which is actuated on the conclusion of each injection cycle and closes off the connecting duct between the worm feed and the injection mould. This can result in a very high pressure building up in the space between the worm feed and the closing device through the continuous feeding activity of the worm feed, which rises the more, the more the delivery quantity increases. It is also possible

for quantities of plastic to collect in the vicinity of the closing device which cool down between each pair of injection cycles and in the following injection cycle are carried forward by the plastic injection and taken into the mould in their cooling state. Defective places can occur in the injection mouldings through this which give rise to a straited deformation within the body and on the surface of the finished injection part, lead to air inclusions and thereby reduce the quality of the injection moulding.

Similar problems result when particularly large articles have to be injected. The injection orifice of the injection mould is then so far removed from the outer ends or edges of the mould that the injection cycle itself involves a very long time, and through the relatively slow movement of the plastic within the large mould during its filling it is at first possible for an uneven temperature distribution to occur. Through this reason also it is possible for irregularities of the kind described to be present in and on the finished injection mouldings.

When particularly long and narrow objects such as pipes and profile sections have to be produced in continuous lengths, then from experience up to the present only extrusion machines are applicable, which maintain a relatively high uniformity of the injection product. So long as it is a matter of articles, the stiffness and form strength and also mechanical stability of which does not have to be particularly high, the extrusion process is adequate for their production. On the other hand however the production of articles such as consumer articles like flower boxes, picture frames, relief mouldings, etc. from plastics according to the extrusion process would be conceivable, if it were possible to fill the injection moulds required for them

with the necessary uniformity in a working cycle kept as short as possible. But it is also necessary to avoid any irregularity in the articles produced, since with increasing length the mechanical stability required also increases, as with structural irregularities a relatively rapid destruction of the articles can occur through the action of forces on their outer ends. The production of plastic skis is particularly in mind here, which must be characterised by a high form strength, high elasticity and high mechanical strength.

For the avoidance of material troubles of the nature described in the finished injection mouldings, an injection head for a plastic injection machine with a fixed-location worm feed has already been proposed, in which in the zone of the conically shaped front end of the feed worm a compression space is formed with an aperture semi-angle smaller by comparison to the obliquity angle of the worm end, which enters into the connecting duct to the injection mould, and in which arrangement the shut-off device is constituted in the form of a sleeved stop-plug disposed across the feed direction and rotatable through an angle of 90° about its longitudinal axis. This stop plug has a recess in the form of a groove running transversely to its longitudinal axis from its outer surface, the height of which coincides with the diameter of the connecting duct and which in the open position of the stop-plug connects the compression chamber with the injection mould.

In an arrangement of this kind for a plastic injection machine there is a space in front of the worm feed which ensures an optimum pressure distribution upon the components delimiting it in the closed position of the locking bolt. This space is delimited on the one side by the rotated feed worm, on the other

side by th cess of the stop plug. In closed position of the stop plug it is therefore possible for an exceptionally high compressed and molten pack of material to be formed within the compression chamber which maintains its temperature constant, since it is in communication with the heated feed worm and the further quantities of material constantly arriving. If the stop plug is then opened, then this pack of material is fired through the connecting duct at a high velocity into the injection mould. Since the stop plug is provided with a groove and not with a transverse drilling, this groove is constantly in communication with the hot material pack, so that a quantity of cooled plastic cannot build up to be led into the injection mould by the injection process.

This arrangement of the head reliably avoids the occurrence of material troubles in the injection mouldings, so long as these have normal sizes for workable plastic articles. If however articles of greater dimensions or long and narrow parts are injection-moulded, then it is possible as a result of the problems already described for material troubles to be produced again with the injection process into large injection moulds, which have a similar effect to those faults which could be avoided per se with an injection head of the kind described, but are not to be directly overcome through measures applied to the injection head.

It is consequently the object of the invention to construct a plastics injection-moulding machine which while maintaining the advantages of known or proposed techniques makes possible a satisfactory production of the largest plastic articles also without the formation of structural faults and with a high strength.

A plastics injection machine of the kind initially

referred to is so constituted for the solution of this problem in accordance with the invention that the worm feed arrangement comprises a plurality of feed worms that are in each case disposed in a feed casing, that each feed casing is connected directly with the injection mould through its own duct and that the closing means preferably incorporates simulteneously operable closing elements, each disposed in one direct duct.

With an injection machine so constructed it is possible to produce very large plastic articles in a short working cycle, while at the same time a very high uniformity of the structure of the articles is guaranteed. Through the fact that the worm feed arrangement comprises a plurality of feed worms which in each case are disposed in one feed casing, as a result of the steadily turning feed worms of the continuously working machine there is at any time a pack of material available in each feed casing, which on the opening of the closing device is fired at a high velocity and high temperature into the injection mould. As a result of the employment of a plurality of feed worms, this mould can be furnished with a plurality of injection orifices, so that each injection orifice feeds a pre-determined zone of the injection mould. This can be effected with greater uniformity, as the closing device exhibits simultaneously operable closing components. In this way it is ensured that a quantity of plastic corresponding to the number of feed worms used reaches the injection mould within a time corresponds to the injection time for small objects. In this way it is possible to construct an injection machine which makes use of the advantage of an injection head with steadily rotatable worm feed and the highly-compressed material pack possible with this, and in addition with a very short production time guarantees the injection of large articles

with high uniformity, without the need to fear material troubles of the kind described.

Advantageously an injection machine in accordance with the invention is further so constituted that the ducts are connected to injection apertures uniformly distributed over the injection mould and that pressure loading means for the closing of the injection mould are disposed in a distribution corresponding to the injection orifices.

A machine constituted in such a way makes possible a further improvement of the quality of injected articles. If a plurality of pressure loading means is employed for the closing function, then it is possible to obtain a high uniformity of the injection process and an accurate dimensional control of the articles injection-moulded using very large moulds, since particularly with the use of hydraulically powered pressure loading means in the distribution quoted it is ensured that the moulds are pressed together with a very uniform pressure distribution. This is of special importance, since as a result of the use of a plurality of injection orifices, it is possible through the increased pressure of the packs of material being fired into the mould for differing internal pressures to occur within the mould, which must be opposed by a uniformly high pressure effect of the movable parts of the mould. Also the danger of a warping of for example large aluminium moulds is considerably restricted.

The machine described above can further be advantageously constituted in such a way that each injection orifice is opposit to a means of pressure loading. In this manner it is possible to evolve symmetrically working arrangements which are the same in form on the injection head side as on the side of the pressure

loading means. For large round moulds for example a triangular arrangement would be conceivable, which incorporates as it were "bundled" three feed worms on the one side of the injection mould and in matching distribution three pressure loading devices for the moving part of the injection mould on the other side. A machine is however also conceivable, which is for example suitable for the production of plastic skis and exhibits two worm feed units beside one another for superimposed, which are suited to a long and narrow injection mould. Two pressure loading means are then provided on the movable side of the injection mould.

In the case of each of these forms of embodiment of an injection machine it is possible for the whole mobile unit for the movable part of the injection mould to be so executed, that only a relatively weak means of pressure loading is provided for the guiding of the movable part onto the fixed part of the injection mould, which acts upon a central point of the movable part of the injection mould, while a plurality of more powerful pressure loading means is provided for the production of the final closing pressure only coming into effect when the central pressure loading means has reached the closed position. In this manner it is possible for a plastics injection machine in accordance with the invention to be constructed relatively economically in cost, since not only does it consist of a simple multiplication of single injection machines, but the whole construction can be such that a machine results that is no larger than the injection mould used, with which however as a result of the symmetrical construction certain parts are only singly present.

One embodiment example of an injection machine in accordance with the invention is now described on the basis of the general view shown in the figure.

The figure shows schematically the construction of a plastics injection machine with two superimposed worm feeds in a longitudinal section. Such an embodiment example of a plastics injection machine in accordance with the invention is especially suitable for the injection of long and narrow objects, for which reason the injection mould is thus arranged standing upright. The machine is built up on a base frame 10, which carries a plurality of vertical frame parts 11, 12, 13 and 14. The frame parts 11, 12 and 13 serve for the support of the two worm feed units with their related drives one above another and also for the retention of the fixed part of the injection mould. The frame part 14 serves for the support of the movable part of the injection mould and can be mounted fixed; an adjustment of this frame part 14 is however also possible to varying distances relative to the fixed part of the injection mould, as is now described.

The screw feed units consist essentially of a drive and the actual feed casing, which in each case is connected at its front end with the injection mould. The lower worm feed unit incorporates a drive 23, which for example is constituted by an electric motor with a flange-mounted gear box and is coupled to the worm feed 15 through a coupling and bearing arrangement 24. The worm feed 15 is provided with a feed screw which can if necessary consist of a plurality of thread starts running parallel. It is placed in a feed casing 17 that is mounted between the frame parts 12 and 13 and can for example be connected through the terminals 17a and 17b with an electrical current source which supplies the current necessary for the electrical heating of the feed casing 17. Another form of heating for the feed casing is likewise conceivable. The feed casing 17 is further provided with a filling aperture 27, over which a funnel 19 is shown

schematically. This aperture 27 serves for the introduction of the raw plastic material. Transverse tie rods 19, 20, 21 and 22 brace the frame parts 11, 12 and 13 and together they constitute a rigid combined framework. An upper worm feed unit similar to the lower one likewise incorporates a drive 25, and coupling and bearing arrangement 26 and also a worm feed 16 located in a feed casing 18, the threads of which are indicated schematically. The upper feed casing 18 has a filling aperture 28 and is supplied with electric current for heating at 18a and 18b. A funnel 30 is likewise indicated schematically over the filling aperture 28.

When the two worm feeds 15 and 16 are rotated by their drives 23 and 25 the plastic material filled through the funnels 29 and 30 is taken up by the threads of the respective feed worms 15 and 16 and masticated in the heated feed casings 17 and 18 respectively. Through the feeding action of the feed worms 15 and 16 the plastic is then moved forwards within the feed casings 17 and 18 respectively, that is, towards the right in the figure, so that a masticated pack of plastic material can be collected in a compression chamber 32 or 42 respectively in front of the feed worm 15 or 16 respectively concerned, which achieves an extremely high pressure as long as a closing device which constitutes the forward closure of the compression chamber 32 or 42 concerned remains in its closed position. The compression chambers 32 and 42 are constituted by what are known as injection heads 31 and 41 that are fixed to the frame part 13 in a suitable manner, and this also supports the front ends of the feed casings 17 and 18 respectively. The conical configuration of the compression chambers 32 and 42 is such that an optimum pressure distribution with the highest possible pressure values and uniform temperature distribution are ensured for the material fed.

The closing device on the front or outlet ends of the compression chambers 32 and 42 contains a rotatable shaft 36 that can be turned about its longitudinal axis through a lever connection 37. The shaft 36 carries on its upper and on its lower end in each case a closing pin 34 or 44 respectively guided in sleeves 33 and 43 respectively, and constituting in the way indicated a connection through a drilling or a groove machined laterally when in its open position between the compression chamber 32 or 42 concerned and a duct 35 or 45 respectively, which leads to the injection orifice of the fixed part of the injection mould. The ducts 35 and 45 are machined in a support plate 38 which serves for the retention of the fixed part of the injection mould, not shown in the figure. The support plate 33 can be fixed on horizontal bearer rails 40 and 46, the rearward one of which is to be seen in the section drawing. These bearer rails 40 and 46 serve simultaneously for the guidance of the movable part of the injection mould, as it is now described.

The movable part of the injection mould can be fixed to a support plate 39 which is movable by hydraulic drives on the bearer rails 40 and 46. The whole of the movable assembly can be guided for this purpose onthe bearer rails by means of guide claws not illustrated, which where necessary are introduced in fixed predetermined locations using spacers. Three hydraulic drives 50, 60 and 70 are mounted with their pressure cylinders 51, 61 and 71 on the fixed frame part 14. The fixed frame part 14 can be mounted fixed or movable as described on the supporting frame 10 of the machine. In the figure a spacing element 47 is indicated for a possible height adjustment of the frame part 14, with which the movable part of the injection mould can be adjusted in its height on the support plate 39 relative to

the fixed part of the injection mould on the support plate 39 in a precise manner.

The lower and the upper hydraulic drives 50,and 70 are made more robust than the middle hydraulic drive 60. The middle drive 60 serves purely for the forward movement of the movable part of the injection mould on the support plate 39 against the fixed part of the injection mould on the support plate 38 initially, and thereafter it supplements the hydraulic drives 50 and 70. At first it is thus not necessary for such a high pressure loading force to be produced as is necessary in the closed state of the injection mould, in order to counter-act the high pressure with which the plastic is charged into the injection mould. The middle hydraulic drive 60 has two hydraulic connections 63 and 67, the forward movement being produced across the connection 63 and the return movement through the connection 67. The lower and the upper hydraulic drives 50 and 70 have hydraulic connections 53 and 73 which are subjected to pressure effects in such a way through the machine control that at the time of the retraction of the whole group with the middle drive 60 no hydraulic pressure is produced in the lower and the upper drives 50 and 70, so that a satisfactory retraction of the whole group is possible.

The lower hydraulic cylinder 51 contains a piston 52 which is sealed in the cylinder 50 through the seals 54 and 55 and is connected at its front end by means of bolts 56 with the support plate 39 of the movable part of the injection mould. Likewise the upper hydraulic drive 70 has a hydraulic cylinder 71, in which a piston 72 moves and is sealed in the cylinder 71 by means of seals 74 and 75 and is connected by bolts 76 in the support plate 39 for the fixed part of the

injection mould. The two hydraulic drives 50 and 70 are opposite to the ducts 35 and 45 of the fixed support plate 38, so that the uniform distribution of pressure possible with the invention is ensured for the entire pressure pattern in the injection mould. To ensure satisfactory forward and backward movement of their pistons 52 and 72, the hydraulic cylinders 51 and 71 are furnished with apertures 57 and 77, through which a pressure balance with the ambient air can be effected during any movement.

The middle hydraulic drive has a cylinder 61 in which a piston 62 moves, which is connected by bolts 66 with the support plate 39 for the movable part of the injection mould. The piston 62 is provided with seals 64 and 65 that constitute two working spaces, the rearward of which communicates with the connection 63 and produces the forward movement of the whole group, and the forward space, communicating with the hydraulic connection 67 produces the backward movement of the whole group.

The machine illustrated in the figure makes possible a very brief injection period for long and narrow articles. The moulds of these articles are fixed on the support plates 38 and 39, and the closing movement of the injection mould is produced through actuation of the middle hydraulic cylinder 60, which through the machine control is subjected to an appropriate pressure loading through the connection 63. When the mould is closed through movement of the support plate 39 from right to left, then the hydraulic drives 50 and 70 come into action in addition and together exert the high closing force on the injection mould required for a satisfactory injection process. This force is produced directly opposite the injection orifices, as this is illustrated in the figure by the direction of the

two hydraulic drives 50 and 70 at the ducts 35 and 38 of the support plate 38 shown. When the mould is closed the stop plug is actuated through the lever link 37 by the machine control in a manner not shown, and the highly-compressed and masticated plastic in the compression chambers 32 and 42 resulting from the continuous feeding action of the worm feeds 15 and 16 can be fired through the connecting ducts 35 and 45 into the injection mould, when, taking into consideration that fact that two such ducts 35 and 45 are provided, each feed worm only has to furnish one half of the injection quantity needed for the injection process. Thus for the injection of the whole of the large articles only the time is needed that corresponds to the time for the injection cycle for an article of half the size with only one worm feed unit.

As has already been described, it is also possible for other arrangements to be found deviating from the form of embodiment illustrated. It is possible with the design principle illustrated to evolve further inter-related applications of the worm feed units; for example three worm feed units can be disposed symmetrically one to another in accordance with the angles of an equilateral triangle, through which it is possible to fill large and round injection moulds satisfactorily.

The Claims defining the invention are as follows:

1. A plastics injection-moulding machine with a fixed location and continuously rotatable worm feed unit and an intermittently operable closing device provided between the form feed unit and the injection mould interrupting the supply of plastic into the injection mould, wherein the worm feed unit incorporates a plurality of worm feeds which are disposed each in a feed casing, each feed casing is directly connected with the injection mould through its own duct, and the closing off device incorporates simultaneously operable closing elements each disposed in one duct.

2. A plastics injection-moulding machine as in Claim 1, wherein the ducts are connected with injection orifices distributed uniformly over the injection mould and pressure loading devices for the closing of the injection mould are disposed opposite each of the injection orifices.

3. A plastics injection-moulding machine as in any one of the preceding claims, wherein two worm feeds are disposed one above the other.

4. A plastics injection-moulding machine as in Claim 3, wherein a mould carrier plate common to both worm feeds is disposed in front of the outlet ends of the feed casings, through which the ducts run and which is fixed to external bearer rails.

5. A plastics injection-moulding machine as in Claim 4, wherein the bearer rails are disposed parallel to one another on two longitudinal sides of the machine and a further mould carrier plate is held movably by means of guide components fixed thereto.

6. A plastics injection-moulding machine as in any one of

Claims 3,4 or 5, wherein the movable mould carrier plate is connected to preferably hydraulic driving elements, two of which are disposed opposite to the ducts of the first mould carrier plate.

7. A plastics injection-moulding machine as in any one of Claims 3 to 6, wherein the closing off device exhibits two stop plugs each guided in a sleeve and which are provided with a recess machined running from their outer surface transversely to their longitudinal axis in the zone of the ducts and are joined together through a rod rotatable about its longitudinal axis.

8. A plastics injection-moulding machine as in Claim 7, wherein the closing off devices are disposed between the outlet openings of the feed casings and the first mould carrier plate.

9. A plastics injection-moulding machine substantially as hereinbefore described with reference to the accompanying drawings.

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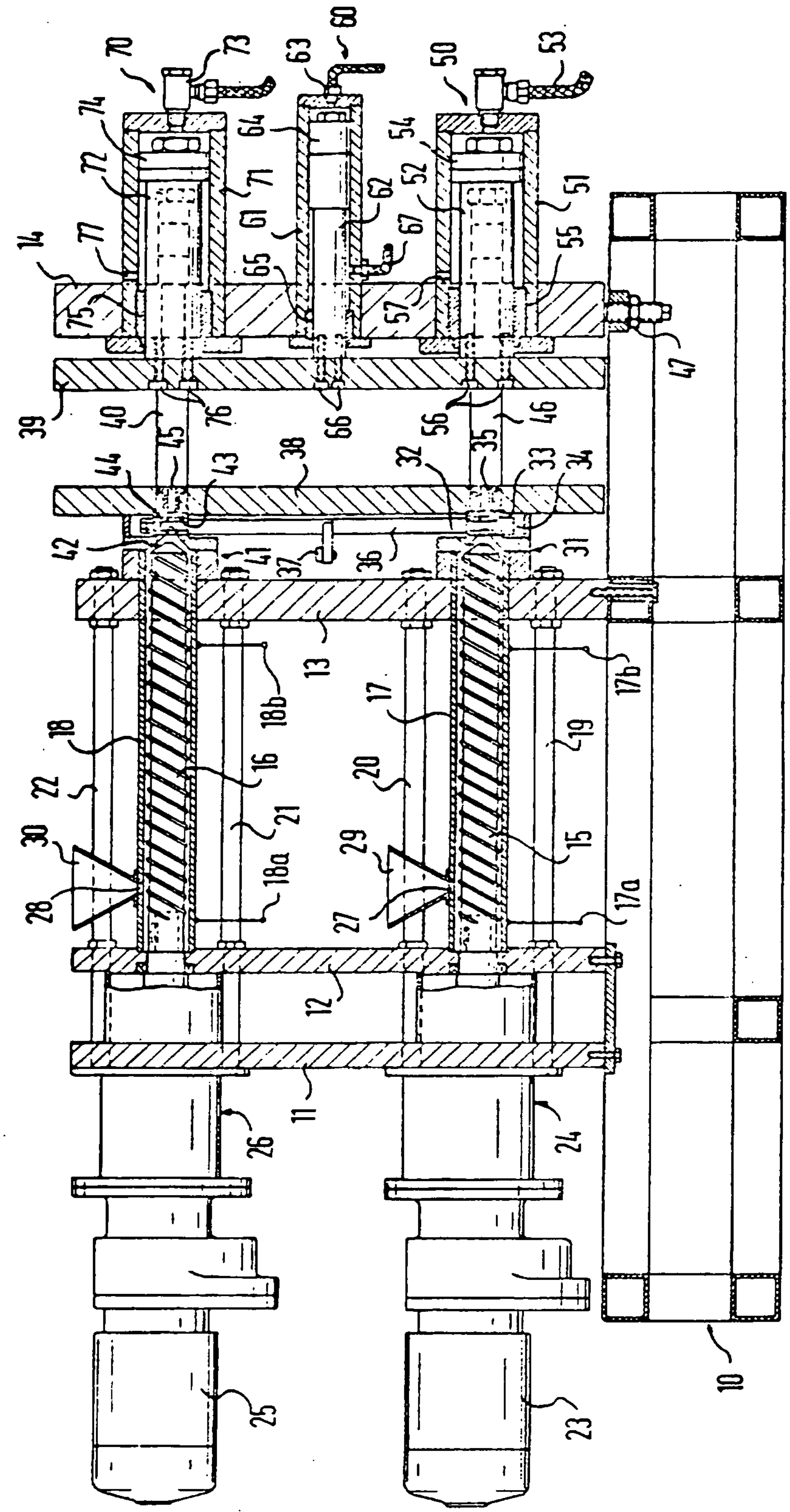
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